Ecological Flows Science Advisory Board (EFSAB)
Meeting Summary
October 18, 2011
Archdale Building, Raleigh NC

X   APPROVED for distribution 12/18/2011

Attendance

Members
Donnie Brewer, EMC
Bob Christian, NC Marine Fisheries Commission
John Crutchfield, Progress Energy
Linda Diebolt, Local Governments
Chris Goudreau, NC Wildlife Resources Commission
Jeff Hinshaw, NC Cooperative Extension
Jim Mead, NC Division of Water Resources
Sam Pearsall, Environmental Defense
Judy Ratcliffe, NC Natural Heritage Program
Jaime Robinson, NCAWWA-WEA (online)
Jay Sauber, NC Division of Water Quality
Bill Swartley, NC Division of Forest Resources

Alternates
Cat Burns, The Nature Conservancy
Vernon Cox, NCDA&CS
Sarah McRae, US Fish and Wildlife Service
Vann Stancil, Wildlife Resources Commission
Steve Reed, NC Division of Water Resources
Fred Tarver, NC Division of Water Resources (online)
Holly Weyers, Director-NC Water Science Center

NC Division of Water Resources
Don Rayno
Sarah Young
Jucilene Hoffman

Facilitation Team
Mary Lou Addor, Natural Resources Leadership
    Institute (NRLI)
Patrick Beggs, (WECO) Watershed Education for
    Communities and Officials
Christy Perrin, (WECO) Watershed Education for
    Communities and Officials
Nancy Sharpless, Natural Resources Leadership
    Institute (NRLI)

Guests:
  Klaus Albetin, CH2M Hill
  Mary Davis, TNC/SARP (online)
  Michelle Cutrafello, RTI
  Ken Rekhow, RTI
  Erin Wynia, NC League of Municipalities

The purpose of the Ecological Flows Science Advisory Board:

The Ecological Flows Science Advisory Board will advise NC Department Environment and Natural Resources (NCDENR) on an approach to characterize the aquatic ecology of different river basins and methods to determine the flows needed to maintain ecological integrity.

Presentations, reports, and background information about the E-Flows SAB are available at:
www.ncwater.org/sab

NOTE: The next meeting of the EF SAB is **12:30, November 15, 2011** at the
Wake County Agriculture Services Building
4001 –E-Cary Drive, Raleigh, NC 27610
Free parking is available

October 18, 2011 Quick Summary:

A. Decisions Made:

A. The August 16, Meeting Summary was approved for publishing to the DENR Website and has been posted.

B. Schedule to provide comments for the September 20, 2011 Meeting Summary is as follows:
   i. Oct 24 – receive edits/revisions
   ii. Oct 31 – distribute review/ approval
   iii. Nov 15 – approval of Sept 20 meeting summary

C. Schedule of 2012 Meeting Dates (all Tuesdays meetings):

Jan 17	No July meeting
Feb 21	Aug 28
No March meeting	Sept 25
Apr 24	Oct 23
May 29	Nov 27
June 19	

B. Suggestions for How to Most Usefully Present Data for Assessment

A. Treat all four seasons equally, not weighted, when generating bar graphs for comparison purposes.

B. Have available individual species'/guilds' responses under the scenarios presented for a particular stream.

C. Provide a "cheat sheet" for each site presented, including: species included, stream cross-section, channel characteristics, percentage of each habitat type that went into the model.

D. For each site presented show two charts, one summarizing species/guilds below 80% of unregulated under a given flow scenario and one summarizing species/guilds above 120% of unregulated for a given flow scenario, rather than combining those into one chart.

E. For comparison purposes only, for each class use the same suite of species/guilds for each site.

F. Jim Mead will send out reworked charts/summaries per the above suggestions via e-mail for analysis and comment between now and January.

I. Executive Summary (Exec Summary added by facilitators Feb 2013)

Meeting purpose:

To review habitat modeling scenarios that result in deviations more or less than 20% from 100% using the Eno River State Park site.

Presentation And Discussion Of Deviations of >20% for Eno River Flow Scenarios, by Jim Mead

Jim Mead, NCDWR, presented graphs of habitat modeling scenarios using the Eno River, specifically to show percentage of guilds/species with less than 80% available habitat and more than 120% available habitat. This was in response to requests from EFSAB at the September 2011 meeting.

Jim presented tables showing available habitat under the three categories of flow regimes (traditional minimum flow scenarios, percentage of average yearly flow as minimum flow, and percentage of ambient daily flow). He also showed tables that counted the number of guilds/species at less than 80% or more than 120% for each unregulated flow scenario. Seasons were weighted by how many months were included in the season. He also showed a bar chart with all four seasons, fifteen flow regimes, and percentages of all guilds/species outside of the 80% to 120% of natural, unregulated flow regime.

He noted that when you take a % of ambient flow, the habitat does not change as much and retains more variability. He invited EFSAB members to share thoughts on the weighting of seasons and the way the data was displayed.

Questions, Comments, and Concerns Raised
- Can we determine that traditional minimum flow regimes like 7Q10 the worst case scenarios for guilds/species, or do we need to see more sites to decide?
- Do other small flashy streams follow similar patterns to the Eno River site?
- It's important to see how each guild fares in each scenario.
- The deep/fast/grave/cobble guild (DFGRCOB) is impacted under every scenario except in winter- it has a narrow range of suitable flows.
- Seasonal effects (like spawning time) happen at different times in different regions of NC.

Proposed Actions or Identified Decisions to be made:
- More data points are needed before drawing conclusions or narrowing focus.

Existing Habitat Model Sites for Each Hydrologic Stream Classification (Jim Mead)

NCDWR shared a list of each of the seven stream classifications showing where they have habitat study sites and physical habitat models (a total of nine), though river basin models are not complete for all. They conducted habitat modeling scenarios for another small flashy stream, Buckhorn Creek, to compare with the Eno River results. The EFSAB discussed the classification process that resulted in this list of streams.

Questions, Comments, and Concerns Raised
- The Tar and the Eno are physically different, though hydrologically similar. It seems unlikely that they would be in the same class.

- New information on how to add to or test the hydrologic classification will be helpful.

- Classifications should be compared with actual physical habitat measurements.

Proposed Actions or Identified Decisions to be made:
- New information on how to add to or test the hydrologic classification needed-Mary Davis will present on classification in November.

Decisions and Recommendations : None

Presentation and Discussion: Additional Small Flashy Stream Scenarios (Jim Mead)

Jim presented habitat modeling scenario results from Buckhorn Creek, in comparison with the Eno River.   While the numbers were not exactly the same, they were very similar.

Questions, Comments, and Concerns Raised
- The group discussed possibilities for why the Eno was more sensitive than Buckhorn for % inflow scenarios.

- The group discussed possibilities for why the number of species with >120% is higher for Buckhorn (Cape Fear Shiner, Creek Chub, which are only included for Buckhorn)

Proposed Actions or Identified Decisions to be made:
- Jim Mead will re-run the scenarios with seasons not weighted.

Decisions and Recommendations (for presenting habitat modeling scenario results) :
- Treat all four seasons equally, not weighted, when generating bar graphs for comparison purposes.
- Have available individual species'/guilds' responses under the scenarios presented for a particular stream.
- Provide a "cheat sheet" for each site presented, including: species included, stream cross-section, channel characteristics, percentage of each habitat type that went into the model.
- For each site presented show two charts, one summarizing species/guilds below 80% of unregulated under a given flow scenario and one summarizing species/guilds above 120% of unregulated for a given flow scenario, rather than combining those into one chart.
- For comparison purposes only, for each class use the same suite of species/guilds for each site.
- Jim Mead will send out reworked charts/summaries per the above suggestions via e-mail for analysis and comment between now and January.

NC DWR Annual Report to ERC/General Assembly (Steve Reed)

Steve Reed provided an overview of what the NC Division of Water Resource (DWR), will present in their November 1, 2011 report to the Environmental Review Commission (ERC) and the General Assembly regarding the Ecological Flows Science Advisory Board. The major thrust of the report is to provide a status report of where NC DWR is with respect to river basin modeling. The report will include a chart that depicts a timeline for completion of the models (the Tar River and the Board River are expected to be completed at the end of this year).

Questions, Comments, and Concerns Raised: None
Proposed Actions or Identified Decisions to be made: none
Decisions and Recommendations : None

Discussion: Proposed Agenda Items for Upcoming Meetings (Mary Lou Addor)

Mark Cantrell and Tom Cuffney provided suggestions for ecological discussion topics-
ecology and flow patterns, and melding of ecology and hydrology.

Questions, Comments, and Concerns Raised:
- Mary Freeman or Jonathan Kennen (AFCS Basin, GA) would be an ideal speaker
  regarding relating hydrology to ecology.
- The hydrology reference condition is unregulated but we don't have unregulated
  habitat to look at.
- Biological classifications look at fish or bugs- how to mesh and/or compare these?
- A generalizable strategy that allows the state to make good decisions is needed,
  using data we have or can get.
- Approaches to meld biology/hydrology include 1) a test of organism fidelity against
  the classes would help validate the classes and give them a biological aspect, or
  2)develop a biological classification system.
- How do we define a reference stream- one with unaltered or unregulated flow
  (prevailing conditions- period of record)? How to measure departure from the
  reference state?
- What approaches are other states taking (TX, FL, VA)?

Proposed Actions or Identified Decisions to be made:
- Mary Davis will present on other states efforts and ELOHA in Nov.

Decisions and Recommendations : None

Discussion: EFSAB Charge: Framing a Discussion (Mary Lou Addor)

A review of the charge was initiated to frame a discussion, as several members have
questions. EFSAB members discussed what the EFSAB is, is not, and its purpose and
authority.

Questions, Comments, and Concerns Raised:
- How to move beyond flow to characterize ecology?
- What will be our end result and how will it be measured?
- We need to define the ecological attributes that are desired and measured.

Proposed Actions or Identified Decisions to be made: none
Decisions and Recommendations : None

II. Welcome, Agenda Review, and Introductions   (Sharpless)

Nancy Sharpless, facilitator, welcomed everyone to the eighth meeting of the Ecological Flows Science Advisory Board (EFSAB).   She introduced herself, and requested that the facilitation team and all other attendees introduce themselves. Nancy reminded the Science Advisory Board of the purpose of the EFSAB. She oriented everyone to the meeting facility and to the ground rules. She requested that the EFSAB members speak into the mic and that the presenters (or facilitators) repeat/paraphrase questions being asked.

Nancy reminded everyone that a public listserv is available to non-EFSAB members; this listserv distributes information relevant to the EFSAB to the public at large. Those interested can register for this listserv here.

Nancy reviewed what was accomplished at the Sept 20, 2011 meeting, and then introduced the October 18 meeting agenda:

- 12:00   Registration & Orientation to Meeting Room
- 12:30   Welcome 8th Meeting of the Ecological Flows Science Advisory Boar
- 1:00   Presentation and Discussion: Deviations of Flow Scenarios
- 1:45 Existing Habitat Models Sites for Each Hydrologic Stream Classification
- 2:00 Break
- 2:15 Presentation and Discussion: Additional Small Flashy Stream Scenario
                    Buckhorn Creek/Cape Fear (includes 23 guilds)
- 3:15 NC DWR Annual Report to the ERC/General Assembly
- 3:30 Discussion of Proposed Agenda Items for Future Meetings
- 4:15 EFSAB Charge: Framing A Discussion
- 4:30 Adjourn

II.   Presentation & Discussion: Deviations of Flow Scenarios (Mead)

Reference Slide: Eno River State Park site - Percentage (weighted by # of months in each season) of Guilds/Species with Less Than 80% or More Than 120% of Unregulated Index B Value.

Presentation

Jim Mead, DWR, started his presentation by looking at a table **(Appendix A)** showing available habitat under various flow scenarios, for each of 23 guilds or species (rows), shown as a percentage of the habitat available under unregulated Index B values (where Index B is calculated as the average of all habitat values in a month (for all years) that are between the 10% exceedance level of habitat and the 90% exceedance value for that month. The highest and lowest 10% of the habitat values for the month are not included in the calculation).

The table is divided into three broad types of different flow regimes (the colored columns) for the Eno River Site. If a box is highlighted in yellow the value in that box is either less than 80% or greater than 120% of the unregulated Index B value achieved by a flow scenario. The three different colored panels (rose, blue, and green) represent categories of flow scenarios, where rose includes more traditional minimum flow types of scenarios, the blue represents flow scenarios where a percentage of the average yearly flow is the minimum flow regime, starting with 10% average flow on up through 60% average flow. The green panel includes five

different flow regimes where the downstream flow is a percentage of the ambient flow, where the flow is adjusted daily.

Another way of looking at these flow scenarios shown in green is that there is a cap on the percentage of ambient flow that can be removed from the stream for off stream purposes. For example, 70% flow-by means that 30% of the flow on any given day can be used for off stream uses. [For a list of the abbreviations used for guilds and species on the Eno, **see Appendix B**]. One way to take a quick glance at this is to see how many yellow boxes are there for a given flow regime. For each of those three groupings (rose, blue, and green) of flow scenarios, the one on the left in each of the colored panels tends to be the one with the most yellow boxes because these are the lower flows in that group. Also, looking at the minimum and maximum values in each column, there is quite a wide spread, but that spread tends to narrow for the flow regimes in the green panel. When you take a percentage of the ambient flow, the habitat does not change as much and retains more variability so that when you compare it to the habitat you have with unregulated flow, there is less difference. Jim generated a sheet like this for each season at the Eno River site.

These tables were then converted to a "counter" type of representation **(Appendix C),** where for each row (guild or species) for each flow scenario, either a 1 or 0.01 is placed in the cell. A "1" represents a seasonal Index B value of less than 80% of the unregulated flow value, and a 0.01 represents a seasonal Index B value of greater than 120% of the unregulated flow value. This representation allows for an individual count of how many guilds/species are at less than 80% or greater than 120% of the habitat value for unregulated flow.

Summaries are shown at the bottom, indicating that, for example, for 7Q10, 20 out of 23 species/guilds would have available habitat less than 80% or greater than 120% of the habitat available for that species and guild under unregulated flow conditions. The one guild (SSYOY) in that column showing a value of 0.01 (available habitat greater than 120% of available habitat under unregulated flow conditions) is one that likes really slow really shallow conditions. The table also indicates at the bottom, for each flow scenario, the percentage of guilds/species that have less than 80% or greater than 120% of the habitat available under unregulated flow conditions for that season. The bottom row is a weighted percent. The seasons are weighted by how many months are included in that season. This was done because the EFSAB wanted to boil down this data to one plot for each study site showing all four seasons on one plot in order to readily compare one site (such as the Eno River site) to another.

Different sites are going to have a different count of guilds/species. For example, the sites in the mountains are going to have trout so they might have 28 guilds/species rather than just 23. For coastal streams a few guilds/species may drop out. Each site may not have the same total number of guilds/species that could be inside the 80-120% band. By using the percentage of total guilds that are in the 80-120% band, the tables' information is easier to use for comparison from site to site. A table like this was created for each season. To put this all on a scale of 0-100% for generating a bar chart showing all four seasons combined, Jim weighted each season. The way months were grouped for each season, the seasons were not all of equal lengths (they are not all three months). Instead, fall is only two months (October and November); winter is four (December-March); therefore the seasons were weighted by the number of months that fall into each

season. He pointed out that this bar chart shows all four seasons, fifteen flow regimes, and the percentages

of all the guilds/species that are outside of the 80% to 120% of natural, unregulated flow habitat metric. The taller the bar, the more different the habitat is for that flow regime from what it is in a natural, unregulated flow regime.

As the bars get shorter, the more similar the habitat is to natural, unregulated flow. He noted that there is nothing magic about the 80-120% band; he thought it was a good idea [suggested at the September EFSAB meeting] to include deviation 20% above the natural flow as well as the 20% below. Habitat's exceeding that found with unregulated flow is not necessarily positive. There could be unintended consequences of increasing habitat above that found under natural flow conditions. Jim invited EFSAB members to share thoughts on the weighting and the way the data is displayed.

Discussion

Question (Q): Can you go back to the table showing the counts **[Appendix D]**? I have a pretty good feel for what the flows should be for 7Q10, and I am assuming that the 7Q10's would normally be reached most often either in the summer or in what you have defined as the fall. I am trying to compare the results of your model to how often the actual flows in that stream were at or below the 7Q10 during this season. Can you give a percentage estimate of when that might occur naturally?
Response (R): Not off the top of my head. At one of the previous meetings I had a handout showing the flow durations, but I do not have it at this meeting.

Q: Then let's go back to the table showing percentages, rather than the counts **[Appendix E].** Considering how often the stream under natural flow regimes might be at or below that 7Q10 value, how appropriate is it to expect to achieve an 80% value under a natural flow condition for any of these guilds?
R: That 80%, remember, is based on the natural varying flows. The 7Q10 is still not going to occur that frequently. Remember that 7Q10 is the flow that occurs over 7 consecutive days once every 10 years.
R: Yes, for calculating the value, but on a daily flow I would expect the 7Q10 value to be reached a lot more frequently, but not necessarily for seven days in a row.
R: More frequently than seven days in a row, but still not that frequently.
R: Okay, that's why I am asking about the flows. I am more accustomed to mountain streams where you expect to see the 7Q10 value frequently, but not for as extended periods of time, perhaps.
R: During the break I can get the flow data from my office. For mountain streams it may be a little more frequently because in the mountains, the 7Q10 can be as much as one-half a cubic foot per second (cfs) per square mile, whereas when you get into the piedmont, particularly with a small flashy stream like the Eno, it is more like 0.1cfs per square mile. We did convert a record of unregulated flows to unregulated habitat so the habitat available under that 7Q10 condition is pretty low. The other thing to remember is that for this first cut, we took the simple snapshot approach to flows. We assumed that whatever water management project there would have the capability of taking all the water out of the stream except the 7Q10 (in this case) all the time, and of course that is not realistic. At some point the flow will reach a level at which the regular flow goes by. That is the case for every one of the scenarios.

Q: So this is like the worst-case scenario for this particular small flashy stream?
R: Yes, it is. Remember too that when we talked about that, another point that was made, which I thought was good, was that during low flow periods, it is much more likely that the pipe can withdraw all the flow

except for whatever minimum is specified. But during the wet times, it is more likely that there is excess flow beyond the minimum.

Q: Is part of our objective to start winnowing down the number of scenarios to where we won't be running all 15 flow scenarios for each and every site?
R: We might reach that point. We can if people feel that it is appropriate to narrow our focus.
R; This might be premature, but in theory we could say the worst case scenarios would be these traditional minimum flow regimes, except perhaps the monthly median. But it might be premature before we know what the results are at other sites. If you have stable flow your 7Q10 might not be that low.
R: That is possible, and I think that is a good point. We probably want to start each of our individual classes running all fifteen scenarios before we start focusing in on fewer scenarios. For small flashy, we want to see more sites. I have one more today. I want to have more than that. When we have seen at least a handful of them, then if they all tend to follow a similar pattern, then we might be able to draw some conclusions to say that some scenarios would not be desirable because they have a very high percentage of guilds with habitat less than 80% or more than 120% of the habitat under unregulated conditions. I thought that it was good to include the greater than 120% in addition to the below 80%, but for the most part, where we have greater than 20% deviation (above or below), it was below. For a few months, for a few scenarios, you could be augmenting the habitat more than would normally be there. That sort of explains why that pops up during a particularly high flow regime.

Q: Can we talk about your weighting scheme? I can see the justification; on the other hand, what it does is make a change in winter twice as important visually as a change in fall when winter may be the least important season for what we are talking about. I think we should discuss that or see if there are some alternatives.
R: I welcome comments on that. We tossed this around and decided to start with this. Another approach would be to treat all seasons equally regardless of how long they are. You could take that even further, I suppose, and say there are certain seasons even more important in their length or in a critical time of year. I don't know about that one. You might start to get caught up with individual guilds or species, depending on when they spawn or what not. It might be a little more straightforward to treat them all the same rather than weight them by number of months in each season.

Q: Who would be your audience for a slide like this **[Appendix E]?**
R: Well, starting with you all, but ultimately I'm not sure that when we go to present this to the public or the Environmental Management Commission or some policy group, we would even get to this point with it. I have a slide I am going to share after the break that is a comparison of the Eno and Buckhorn. Ultimately, I would anticipate having a summary slide that takes each of these plots for each site in a class and combines them. For example, we might show all the small flashy streams on one plot. That is what I would think we would be showing people beyond this EFSAB. Hopefully, we will be able to show that we have a fairly narrow range of variation for the small flashy streams in terms of how high one of these bars is. If we can come up with that I will be very encouraged and pleased. Now if they are all over the place, we may have to go to a Plan B.

Q: One thing that I am curious about. This combines all guilds across the season.
R: For the spawning guilds, I did not include them, where they are shown as grayed out, in the totals.

Q: When you look at this table **[Appendix E],** the DFGRCOB guild is impacted under every scenario. I am curious to know if it is impacted in every scenario in every season. If it is impacted under every scenario does it have a season when it is not impacted? Is there ever a window where this guild is not getting the short end of the stick?

R: Let's look--just once in winter.

C: From the biological aspect, I do think that we need to have something showing us how each guild fares in each scenario. There are scenarios where it might be easy to say that we don't need to run those in this particular case, that they are the worst-case scenarios, but even in the best-case scenarios, some of these guilds may not be faring well. I think that we need to at least have the opportunity to see that and discuss what that might mean for the ecological community or the ecological function at a particular location.

Q: Is that a reflection of the percentage of that habitat that exists and it only takes a small change if you only have a small amount of that habitat in the beginning such that a small amount of change makes a huge change in the percentage of habitat? If that's the case, it might change with a different stream if that stream has a lot of habitat, but if there is another reason within the model or a biological reason then it is going to be consistent with every location. That's what I was getting at with the 7Q10. I think we are going to see that under the annual 7Q10 version that's always going to be impacting nearly all of the guilds, no matter where we are, and I would almost bet on almost every stream type.

C: I think a lot of us appreciate that, which is why we want to move away from those traditional methods, but there are states and there are projects where the annual 7Q10 is the minimum.

C: I had noticed that for that guild (deep/fast/gravel/cobble). We have evaluated that one for several project-specific studies. It's been an outlier. We suspect that it is the way that the habitat suitabilities were developed; they are extremely binary so that you end up with very small specific spots that have suitable habitat. It doesn't take much to make the stream too fast or too slow; you have a very narrow range of flows with suitable habitat for this guild. When we have had specific project proposals to review, we have always taken the results for that one guild with a huge grain of salt. Right underneath that guild we show deep/fast/coarse, which is similar. We have paid more attention to that particular guild response.

Facilitator: So if you remember, last month there was quite a lot of discussion about this, and the big question was whether to include over 120%. Is there something you can see now that is good or anything else that you see that needs to be done?

R: I think it was important to include the over 120%, and I am glad to see the results of that. I don't know if we can start making a judgment about how important it is going to be until we start comparing streams. The Buckhorn results will be interesting.

C: The other thing is if the numbers that had been over 120% had been higher, I would be more concerned about this question--if they had been a much larger contribution toward the total percentage, but for the most part they are not.

C: That's true for this particular stream or it is true for small flashy streams, but we still need to keep that in the conversation for the other classes.

C: Yes, my point is that I don't think we need to sweat whether it should be 130 or 150.

Q: Could you very quickly flash through each season showing this same view **(Appendix E)?** [Jim went through each season's table **(Appendix F, G, and H**]. That answered my question. I am looking at the same thing in reverse. There are several guilds that are either never affected by any of the scenarios, or they never go below the 80% threshold no matter what you do.

C: Particularly in a season like winter where the flows are higher.

Q: We have anadromous fish that are grayed out during some of the seasons, but none of the benthic, such as the caddisfly larvae. Should that be all four seasons?

R: We do model them for all four seasons. Their populations may fluctuate, but they are there year-round.

C: A lot of them have multi-year life histories, and they would be aquatic for more than one year or might have different generations that are at different life stages.

C: Yes, I think that is very appropriate.

R: We have wrestled with this. This is not peculiar to this effort; we have been doing this for a while. It is because of a combination of hydrologic similarity and also because of critical life stages. Spring is typically when you do have anadromous species spawning. Some may be in advance of April, but more of them are April, May and June. Wet months are December through March. December is a little transitional. I took a quick look at the monthly stats for the months as they fall into each of these seasons, and they are not too widely spread. If I had to pick two months that don't fit quite as well within their season, it would be December and June. June is a little dry for spring, compared to April and May. December is a little dry for winter, compared to January through March. I thought about having a 5th season, putting June and December in it. The problem with that is that in June you have all kinds of spawning and things happening while you do not have that at all in December. I did not want to group them together; they are biologically different even though they are similar hydrologically. July, August and September are really dry, and temperature-wise, they share commonality. October can be fairly dry. We thought about putting October in with summer, but flows are starting to pick up, and ecology-wise things are cooling off. At the edges of the seasons you could probably put a month into the next season, and I did not want to separate months in half.

Q: Would you hold the seasons the same for a coastal stream compared with a Blue Ridge stream?

R: I hadn't thought about that.

C: Spawning is usually triggered by temperature in addition to flow so you are going to get the transition to spawning season at a different time depending on where you are in the state.

C: Yes, I think she makes a good point. In fact, Jeff and I were discussing that on the side here. I think we need to be very cautious about being premature in making any conclusions along these lines. What we have been doing for the past hour is talking about an ad hoc version of sensitivity analysis, and that is which guilds are sensitive to what flow conditions when. North Carolina is divided into 29 different level IV eco-regions. Nothing that we do is going to equally apply across the state. The seasons in the mountains are a great deal different from what they are in Carteret County. But what I really do like is that we are starting to see pictures and ways to analyze this information, and what I thoroughly expect is for Jim to come in here in the next 20 minutes and show us these same results for not just one stream type but all stream types, and not just two examples but ten examples for each stream type. At that point, our sensitivity analysis will turn into real science rather than conjecture. It's probably going to be analysis along those lines that ultimately leads to decision-making, but we are a long way from that. While I find this really helpful and insightful, I have to sit on my own conclusions, thinking that this is not reality that we are looking at for North Carolina; this is reality for one or two examples for one stream type, so I am not ready to make decisions yet.

R: Don't hold your breath on having all those ten after the break, although I would note that I am not presenting at the next meeting, then we have a break in December. I hopefully will have a chance to at least double our data points before the meeting in January. I concur with everything just said. We need to have a lot more plots before we start drawing any conclusions or narrowing our focus down. It is very helpful to me, though, to know that at least the way we are presenting the data and the way we are grinding through the data is useful when we get more data points.

Facilitator: Why do you not just stop at 100%; why go to 120%?

R: One reason is that if we make certain kinds of decisions, what we are really doing is bio-manipulation, and we don't want to disturb the ecological balances in one direction or the other.

C: Another way of saying it is that if we made it 100% then we would be saying that anything that deviates from the natural flow is unacceptable. Well, it would be if you made both the top and the bottom 100%. We would just be putting a band of change that we allow to happen; it could be 10%, 5%, 30% or whatever above and below 100%, but we will have to determine that later because it is a sensitivity question. But I think the concept is good. If you get too far one side or the other, there are issues.

C: No model is perfect, and natural systems have a certain amount of resiliency and adaptability. That 20% plus or minus I have often thought of as a certain amount of uncertainty about the modeling and a certain amount of adaptability of the system to change. There is nothing magic about 20%, but over the years talking to biologists, they usually say that they start getting uncomfortable with changes much more than 20%. Even USGS, in measuring just flow considers within 10% being a good measurement, and that's just talking about flow, not the effect on habitat.

III. Existing Habitat Model Sites for Each Hydrologic Stream Classification   (Mead)

Presentation

DWR made a list for each of the seven classifications showing where they have habitat study sites where for one reason or another, a habitat study has been done. **(Appendix I).** Among the small/flashy streams, we will be looking at the Buckhorn Creek site later today. Rocky River is a good site. It calibrated well. It is confirmed small/flashy. I am really interested to see how the Tar looks. Hydrologically, the numbers say it is small/flashy, but it is bigger by far than the others. It is pretty far east, with a pretty sandy bottom. I am curious to see if it will be our outlier. Buffalo Creek I think will work pretty well. It is a new site we did in the last three years or so. It is more in the foothills, and its base flows are a bit higher. The Tar and the Broad are kind of at the edges of what we consider that central piedmont flashy stream. If we were to do each of these, we would have nine data points for small/flashy streams. There might be a bit of an obstacle to doing one or two of those just in terms of mechanics of converting the model to including all the guilds. I think we could at least have five or six to look at.

Discussion

Q: To clarify, the descriptor "small/flashy" is purely hydrologic?
R: Correct.

Q: It's not even habitat based, it's just purely flow?
R: Yes.
C: We are trying to wrap our heads around this because we know that the Tar looks different from the Eno, but physically it is not really relevant because our classification isn't based on physical habitat availability.
R: Everything you said is correct.

C: I think it is kind of hard for us to conceive of these being in the same classification because from a physical aspect, they do not necessarily jive.

R: Right. Now some of those I do see as variations on a theme. Even the Broad, although it is further west, looks not much different from those further east. The Tar really raised our eyebrows. You will notice that some of these have asterisks after them. The reason is that, in order to run this through our classification software where we just input the daily flow, we have to have the flows to input, which means that we have to have one of our river basin models finished to produce those flows.

 [facilitator's note: the river basin models need to be completed in order to confirm the classification of the streams with asterisks next to them.]

We can take the asterisk off the Buckhorn because I did get the flows for that one. Rocky River will surprise me if it is not small/flashy, but the Cape Fear model is not quite ready. It will be ready very soon. For the West Fork and the Swift Creek sites we just need to generate the flows and plug them in to the classification software. I just didn't have time to do them before this meeting. The Broad basin is in development, but it will be a while before we can do it. The Tar study site is right on top of a USGS gage so we had a flow record to confirm that at least as far as hydrology goes, it is small/flashy.

C: I think the important thing here is that even under the very best scenario, you are looking at a small data set. We are only looking at less than a dozen small/flashy streams. The benefit in getting that information on every one we can get is clearly a course we should follow.

C: Right, but the way that these stream classifications are arrived at was based on how far apart they are from one another *[facilitator's note: in terms of flow characteristics, not geographical location]*. There were 185 streams that went into the model that actually pulled them into distinctive groups. We are calling them small/flashy and associating them with that, but there is something distinctive about them hydrologically. There is some power to that.

R: Remember that of the nine listed there, only two of those were actually at the same location as one of those USGS points that went into the classification development--#2 and #8. They are right on top of USGS gages. Those gages were part of the statistical analysis that went into the classification software. All the others are new points in the OASIS model that will have to have flows generated with the OASIS model.

C: When we put the class name of small/flashy on it we were trying to give people the general understanding. The model did not give it any names. We did that. Sometimes we get a picture in our mind. Whether it is small/flashy or not is subjective.

C: I will also note that next month Mark Cantrell and Tom Cuffney, everybody really, will be talking about whether there is something else we can do in addition to the hydrologic classification or to confirm the hydrologic classification or in some way to strengthen the link between the classification and the actual ecology of the streams so that we can be more confident about how we have grouped the streams. It could be an additional layer on top of the hydrology or a test of the hydrologic classification or some way to be sure that it has ecological meaning. I don't want to get too caught up on that today because we are going to be focusing on that next month.

Q: So am I understanding you to say that the Environmental Flows Specialists (EFS) will be on the agenda for the November meeting?

R: The ecological classification and how that does or does not relate to the (EFS) classification will be on the agenda.

Q: So EFS is not on the agenda for November, but the ecological subcommittee will report back in November, is that correct?

Facilitator: Perhaps we could hold that until we discuss the November agenda later in this meeting.

Presentation

Returning to his presentation, Jim took the group through the other classifications. He noted that DWR does not have any existing flow studies for the small seasonal stream class. Jim would guess that is because the seasonal streams (the ones that go to zero flow) are not good places for water supply or hydropower development. Many of the existing habitat studies were done because there was either a water supply or hydropower project. He can think of one site that would qualify, but it did not have a Phabsim type of study; it was a simple wetted-perimeter study on Big Bear Creek.

Among coastal streams DWR does not have a lot of sites, but they do have a few. The first three are pending (the studies are not complete). Nick's Creek is in the Cape Fear basin, but it is more of a Sandhills type of stream. Jim is not sure that the Tar River study will be applicable for the EFSAB's purposes because the more DWR has looked into that study, the more they think it will be looking more at water quality as opposed to the effects on physical habitat. It is a deep, u-shaped channel with stream wood along the edges, and flow doesn't change the water level that much. What changes the water level more than downstream flow is tide. Jim did not know that it would be useful to the EFSAB, at least to analyze results in the same way as other stream classifications.

Looking at the large piedmont rivers, mostly courtesy of hydropower licensing, DWR has habitat study sites on those. They have several different sites as part of the same study up on the Roanoke River. They do have sites below reservoirs on the Catawba, the Yadkin and the Pee Dee.

We have three types of stable streams. On small/stable DWR has a Broad Basin site. Thinking back, that Buffalo Creek site was small/flashy in the Broad Basin. DWR has noticed that as the yields get higher per square mile as you go west around the foothills transition range between the piedmont and mountains, the streams can kind of go either way. They don't know yet which class Roberson Creek will be. The Catawba, again DWR was just trying to make the best call. Without having the flow data to run, it is difficult to say whether it is going to be small/ or medium/stable. DWR is pretty sure that it is going to be stable, but just guessing from the nearby gage that did come out as small stable, they thought probably those two upper Catawba sites are more likely to be small/stable than medium/stable, but they could fall out the other way. As you can see DWR has a fair amount of data for the small/stable streams.

Discussion

Q: So these are just your best guesses based on what?
R: We look at where they are, the drainage area.
C: If I look at the Broad, with the ones that you have categorized, they are all medium/stable.
R: If you look at the map we have (on the DWR website) of the 185 gages and where they fell within the state that was part of it. The other thing is, if there was a gage nearby but not very close, we would look at how that gage was classified. I wanted to try to give people a sense of what our possibilities were here, but we recognize that some of these are going to shift around.
C: I really feel like we might need to draw a different classification or compare our classification with actual physical habitat measurements that have been made across the seasons because there might be a physical classification that is either similar to the hydrologic classification or different. I am concerned that we are labeling our hydrologic classification with physical attributes.
R: As Chris said, perhaps we should have just called it class B.
C: That might be more accurate. I could be wrong.
C: We will get to this later on, but Mary Davis, who will be presenting at the November meeting, is working across the southeast to get at this broader classification issue. We should be able to have a good discussion about this at that point.

Continuing with his presentation, Jim noted more small stable streams with habitat study sites, commenting that there are lots of small/stable stream possibilities.

For medium/stable streams, the first Broad River may be one Jim can run for the January meeting. DWR has flows for it. Dan River at Joyce Mill, on the other hand, was done on the mainframe, making it difficult to bring that model up to modern standards. There is still a pretty good selection of sites on medium/stable streams.

Lastly, for the large/stable streams we do not have a lot, but do have a few.

This gives you an overview of what sites we do have available. It is not ideal coverage; one of our outcomes might be that we need to see more data for one area of the state or a kind of stream to test to see if we are getting the same results for types of streams where we don't have as many data points.

Discussion

Q: Back to the quantification of habitat availability. When you say that you have data for these, are you describing the sites for which you have flow data or do you actually have a reasonable amount of habitat descriptors.
R: This listing is where we have a physical habitat model.
Q: So you have some description, some quantification of habitat at these sites?
R: Yes.

IV. Presentation & Discussion: Additional Small Flashy Stream Scenarios (Mead)

Presentation

After a break, Christy Perrin, facilitator, introduced the group to Jim Mead's next presentation on the results of running various scenarios on Buckhorn Creek, another small flashy stream. First, however, Jim tried to show the flow statistics and flow durations for the Eno, which had been asked for earlier, and for Buckhorn Creek. Unfortunately, the data did not display properly on the computer in the meeting room [facilitator's note: Jim provided these statistics after the meeting. They are included in this summary as **Appendix J** (Eno) and **Appendix K** (Buckhorn)]. He was able to glean some information from the tables. The annual 7Q10 at the Eno River site is 1.08 cfs. Looking at what percentage of the time in September that flow is equaled or exceeded, 5% of the time the flow is greater than 1.9, 10% of the time it is greater than 2.7 so the flow does get down to 7Q10 between 1% and 5% of the time in September, which is a very low flow month. The 7Q10 flow is not common, even in the very low flow months. The 7Q10 value is reached similarly for October and November.

Q: Are those daily or monthly or weekly flows?
R: These are based on daily unregulated flows from January 1, 1929 through April 30, 2008 that go into the statistical duration frequencies.
C: What may be more significant here is the whole snapshot idea that Jim had talked about before in that they are making the assumption that the only flow would be the 7Q10 or lower. But during low-flow months, it would not take that big a withdrawal to keep the flow at the 7Q10.

Moving on to Buckhorn Creek, Jim acknowledged the suggestions during the discussion earlier in the afternoon to treat all four seasons equally, not weighted. He noted that, in retrospect, he thought that was a good suggestion and that he would make the changes. He had not had time to rerun the whole analysis over the

break, however. He generated the same types of spreadsheet and graphs for Buckhorn Creek as he had for the Eno. Buckhorn Creek forms Harris Lake, which is used as cooling water for the Shearon Harris nuclear reactor.

This site is downstream from Harris Lake. He indicated that he would be willing to look at those in detail for Buckhorn, but what he thought was particularly interesting was the comparison spreadsheet, looking at the results for both the Eno and Buckhorn.

With nods from the EFSAB, he showed **[Appendix L].** Jim explained   that he had played around with a three-dimensional overlay, but that made it too difficult to read. Looking at the chart, the red bars are the Eno site; the blue bars are the Buckhorn Creek site, with one plot for each season so you don't have to worry about how they were weighted. Each season is handled separately. One   is weighted by number of months, but he can change that to treat each season the same. He showed the data **[Appendix M]** that went into the charts. The charts show the percentage of the total number of guilds and species that are outside of the 80-120% band. For the Eno in spring, using annual 7Q10 for example, the percentage is 87and for Buckhorn it is 87.5. Jim would like to see the numbers exactly the same for the two sites. Although not exactly the same, the results are fairly similar in their pattern for two sites that were   done 25 years apart in time; they are similar in drainage area: 74 square miles for Buckhorn Creek and 99 square miles for the Eno site. Looking at the bar chart, red is the Eno and blue is Buckhorn Creek.

Discussion

Q: Do you have any idea why Eno is more sensitive than Buckhorn for percent of inflow statistics?
R: No, not off hand. This is for spring.
R: I know, but these are very significant differences.
R: Yes, if you look at the actual numbers that go into that for these percentage of inflows: 35 versus 16; 8 versus 26. Yes, particularly for spring. For winter, not as much. For fall, a little more, particularly for scenarios where there is greater reduction of flow. It would take some digging around to look at individual guilds to see if there is one that is more sensitive at one site than at the other.

Q: Are they all the same guilds?
R: That would be one thing to consider. They are pretty much the same. The one difference is that for Buckhorn Creek we added Cape Fear shiner adult and spawning which is not in the Eno.
R: But the Eno was more sensitive than the Buckhorn.
R: Yes, it is. One thing we did not include for the Buckhorn that was included in the Eno was American shad spawning.

Q: Would it matter what the actual habitat percentages available within each of the streams are? If you had a guild that had a certain percentage of habitat available at any given time and it was 5% in the Eno but 0% in Buckhorn, then you would have no net change in the percent of habitat in the Buckhorn just because it wasn't equally represented to start with.
R: To paraphrase, if we had one guild that was common to both sites, but there was not that much habitat to be lost in the first place at Buckhorn, while there was more at the Eno, that might be one possibility.
R: Right, and I would throw out that we are likely to see that on the Tar too because the habitats are so different so the delta is likely to be something we can't understand for particular guilds versus others.

R: It reinforces your point from the earlier discussion about the importance of not losing sight of individual responses when comparing one site to another. It would take me a while to look at individual guild responses to the original question of why the Eno is more sensitive than Buckhorn for percent of inflow statistics. Another possibility is that whatever habitat was available at the two sites is more sensitive to flow reduction at one site versus the other. The total overall at least was not all over the place.

Q: Would it matter if the actual amount of flow that is consistently available in the two streams is different?
R: Pulling up the data, the 7Q10 in Buckhorn Creek is 0.4cfs. For the Eno it was 1.0cfs. For September, the low-flow month, on the Buckhorn the unregulated 5 percentile flow for September is zero. Ten percent of the time the flow is less than or equal to 0.6 so the frequency of flows on Buckhorn Creek is lower than the Eno. Maybe there is less habitat for particular guilds there to begin with, particularly those that like a little bit deeper, faster flows. Reducing flows, if you are not starting with as much to begin with, could cause significant differences in percentages. I would have to drill down through the data to confirm that one way or the other.

C: On Buckhorn, the number of species that are experiencing habitats that are greater than 120% is much higher. A good portion of the guilds are falling outside on Buckhorn because they have augmented habitat.

Jim then pulled up the spreadsheet that had the count (0.1 and 1 to show whether the change was going more than 20% above or 20% below, respectively) for the four seasons on Buckhorn Creek. This shows that, yes, many are going above 120%, especially Cape Fear Shiner spawning and adult, Creek Chub spawning and adult. None of those four were present and modeled for the Eno.

Jim commended Board members for catching this. He then suggested looking at the lower-flow months to see if they were similar. Even during the low-flow months, Creek Chub adults and Cape Fear Shiner adults are getting pushed over 120%.

Q: Does that suggest that the median flow is actually higher in Buckhorn? If you are reducing flow and that is creating more habitat, wouldn't that suggest that you have a higher median flow? The 7Q10 on Buckhorn was lower than Eno, but if you look at the median flows for both systems, Buckhorn might have a higher median flow such that you would expect that by reducing the flow, you provide more habitat.
C: For winter, the wettest of the four seasons, for those two species, reducing the flow actually augments the habitat.
R: Yes, but looking at the top two guilds, it is becoming much shallower so by having significant reductions in flow, you are creating more shallow habitat.

C: I am just thinking out loud. I wonder if we had stream cross-sections to look at for the two streams if it would explain it; is it a channel shape issue?
C: What this brings up to me is that as we go through more and more examples, we should have a set of characteristics of the stream (cross-section, guilds available, etc.) in a separate file that we can look at quickly to better interpret. Ultimately this is more of interest as we are getting into the weeds rather than the overall thrust of the program. We are just trying to understand what is causing these differences or similarities.
R: I think that is a good suggestion to have a "cheat sheet" for a given site we are looking at, including: the species, flow stats, channel characteristics, cross-section, percentage of each habitat type that went into model. For the shallow slow guilds and species, it may that the Buckhorn site is just a lower-yield stream. You have pretty low flows for a longer period of time. The pattern is the same, but if we split this out into one

summary for less than 80% and one summary for more than 120%, they would be different. That gives me something to think about and look into more and get back to the group about.

C: Another suggestion is to pull out those different species so that the comparisons have the same exact species and guilds.

R: Just for the graphing purposes so that you would be comparing apples to apples.

C: Just use the same guilds for all situations from here on out as a chart to look at.

C: Some of those guilds are not going to exist in some of the classes.

R: Yes, although hopefully within an individual class you could come up with a constant suite. The first fourteen species/guilds and the last three (bug) guilds I would expect to be common to all that we would run.

Jim indicated that he would try to dig into the data some more to see what is going on in the Buckhorn versus the Eno.

Facilitator: Is there anything else anybody wants to look at right now?

Jim returned to site comparisons, noting that you don't see quite as big a discrepancy in the dry months. Interestingly, you don't in the middle, but you do at 70% and at 90%. It is similar for fall.

C: I do think that it would be helpful to be looking at a standardized set of guilds. When we get to a higher level of refinement we should definitely look at individual species' responses in some situations, but it does seem that we need to standardize the guilds.

C: Otherwise, we are adding another variable.

C: Especially in terms of percentages.

C: It also makes me wonder if, instead of having one chart that summarizes everything outside of the 80-120% band, we should have two; one that summarizes everything above 80% and one that summarizes everything above 120%. They are really two different types of changes.

C: You see that with the Buckhorn data because it is so different from the Eno data for some of those guilds that were in those classes.

C: We have a couple of good take-aways. It should not be a huge amount of work to rework some of this and look at some parts more closely. We will not be looking at this type of data again until maybe January. What I would like to do is send out some reworking of this to the group and e-mail back and forth so that I have some idea how to move forward with some of the other sites.

Facilitator: Any other questions or comments about the Buckhorn work?

There were no further questions at that time.

V. NC DWR Annual Report to the ERC/General Assembly (Reed)

Steve Reed provided an overview of what the NC Division of Water Resource (DWR), will present in their November 1, 2011 report to the Environmental Review Commission (ERC) and the General Assembly regarding the Ecological Flows Science Advisory Board. The report is an annual requirement based on the same legislation that established the EFSAB. The NC DWR refers to this legislation as the Improved River Basin Modeling bill. The entire report will be three and ½ pages long. The major thrust of the report is to provide a status report of where NC DWR is with respect to river basin modeling. The report will include a

chart that depicts a timeline for completion of the models (the Tar River and the Board River are expected to be completed at the end of this year).

As part of the report, a paragraph, speaks specifically about the Ecological Flows Science Advisory Board (EFSAB) which is as follows:

Ecological Flows Science Advisory Board: Session Law 2010-143 also required the department to create a Science Advisory Board to assist the department in characterizing the natural ecology of the different river basins and to develop procedures for determining the flows necessary to maintain ecological integrity in surface waters. The Ecological Flows Science Advisory Board was convened according to the guidelines in the legislation and their first meeting was held in November 2010. The Science Advisory Board has met six times so far in 2011 with two additional meetings scheduled for the remainder of this year. All meetings are open to the public and participation is also available through webinars. The board's work will continue through 2012 and possibly beyond. More information on ecological flows or the Ecological Flows Science Advisory Board, meeting summaries, presentations and recordings of the meetings is available on the division's website at http://www.ncwater.org/Data_and_Modeling/eflows/.

VI. Discussion: Proposed Agenda Items for Upcoming Meetings (Addor)

Discussion: Proposed Agenda Items for Upcoming Meetings
Mark Cantrell and Tom Cuffney provided pertinent suggestions for ecological discussion topics and examinations. Foremost, was to tackle a discussion on ecology and the flow patterns, followed with a discussion on melding of the ecology and hydrology. Because Mark and Tom could not attend the October meeting, Sarah McRae and Holly Weyers helped to clarify their proposals with the EFSAB in order to develop future agendas.

Mary Lou Addor reviewed the five topics proposed by Mark and Tom with the goal of finalizing an agenda for the November meeting and beginning to layout additional topics for future agendas. The five topics presented were:

1. **Presentation/Discussion (Mary Davis).**
   Topics for consideration:
   a. What Are Other States (in Scientific Terms) Doing with Respect to Ecological Flows
   b. Discussion of General Stream Ecology and Flow Relationships in the Southeast
   c. Include a review of the ELOHA
      Homework would be provided on the ecohydrology literature, including any potential readings and case studies on what TX, FL, and VA, are doing with respect to ecological flows.

   Other considerations: Do we need others speakers on Ecohydrology? Other mentions include Mary Freeman or Jonathan Kennen to start the group thinking about the ecology.

   Outcomes: assist the EFSAB to converge on what hydrologic variables are most important for biota and for stream geomorphology and relate this back to hydrologic variables in the hydrology classification (assure ourselves that we've covered the biologically important variables)

2. **Presentation/Discussion:** why it is important to have the hydrologic and biologic classification systems approximate one another or at least understand how they relate to one another.

3. **Presentation/Discussion:** regarding reference conditions in NC and how this relates to the hydrologic classification scheme.

4. **Presentation/Discussion:** examine the current "state-of-the-art" in terms of species attributes and how this might relate to the habitat modeling that DWR is doing. (e.g., A database of lotic invertebrate traits for North America; 2006; USGS Data Series; 187; Vieira, Nicole K. M.; Poff, N. LeRoy; Carlisle, Daren M.; Moulton, Stephen R., II; Koski, Marci L.; Kondratieff, Boris C. http://pubs.er.usgs.gov/#search:advance/page=1/page_size=100/auth_last=Carlisle:1)

5. **Presentation/Discussion: a**ddress modeling like maximum entropy models (MaxEntropy model by Mark Enries (FWS) or some adaptation of the WaterFall model. (Probably a discussion for the January 17 meeting).

   Outcomes: as DWR is legislated to provide approaches/models, give consideration to how we might use existing stream ecology data (DWQ sampling, classifications, and others) to model the biology vs. hydrologic flow classification scheme. This could be a MaxEntropy model by Mark Enries (FWS) or some adaptation of the WaterFall model development

The EFSAB asked questions of clarifications about what they heard, provided reactions and discussions in order to prioritize the November and subsequent agendas.

Discussion

C: Within USGS, there is a dedicated group of researchers focused on ecological flow requirements as it relates to biota. Mary Freeman and Jonathan Kennen (USFWS) who are listed as proposed speakers are contributors to this work.

Mary Freeman has been doing this kind of analysis for a long time in the southeast, particularly in the ACFS Basin in Georgia where a ton of work has been conducted. She has also worked in the south Atlantic on the SEAWRAP. Mary Freeman has been involved in a lot of the analysis that relates hydrology to the ecology. Thus Mary would be an ideal speaker for the EFSAB, if we **determined the right set of questions to ask her so that she is prepared with the kinds of information the EFSAB would like to learn about.**

Jonathan Kennen is involved in an overarching project called WaterSmart that looks at water use and water supply, and the effects on ecology. This work is being conducted in the ACFS Basin in Georgia; recently they have been able to collect data when we had zero flows in certain streams. It would not be a problem to get Mary and/or Jonathan to discuss their efforts and findings. The important question for the EFSAB: what aspects of the ecology does the EFSAB think are important to look at as it relates to the hydrology to get at the ecological flow requirements that the state has charged the EFSAB with? Since there is ample data, the EFSAB needs to target what would be important to their discussions and the kinds of questions they would like to explore.

One of Tom's suggestions is to incorporate more of a biological perspective into the EFSAB discussions. A great example of this was the Cape Fear Shiner; we saw how it's in and drove the model based on the hydrology but what do we really know? Is the Cape Fear Shiner there because of a distribution only or there because it was the right habitat requirement and that's why it's not in the Neuse? So again, we think it's important to include the biological perspective to help determine what we really know. Particularly, to determine what aspects of the ecology the EFSAB thinks are important to look at as it relates to the hydrology to help drive these models so that we have a really good understanding of the process.

Regarding Tom's meaning of "reference condition", he probably meant from an EPT index thing and reference condition as it pertains to flow – meaning an unregulated flow, something that is not downstream of a

reservoir; it's your natural habitat. The question is, can you find this as a reference condition in the coastal plains, the Piedmont, and the Blue Ridge?

C: I think it's important to keep Holly's point in mind, that the modeling we have, the models, the habitat measurements are on streams that are modified or significantly modified. Although Oasis flows are unmodified, the streams are (examples provided included Shearon Harris and the Eno). Scour and all these types of things that have biological implications are not being addressed from a reference standpoint. The hydrology reference condition is unregulated but we do not have unregulated habitat to look at.

C: We are comparing modified to modified already and so it's very difficult to determine what the true condition is that the ecology needs when we are not starting there to begin with.

C: I have a question regarding one of the topics suggested for future discussion: talk about why it is important to have the hydrologic and biologic classification systems approximate one another or at least understand how they relate to one another. I believe we need to be clear about what type of biological classification system are we talking about here. There are classifications for fish and bugs but not for aquatic systems. So my question is – what classification system will we use here? And how will we mesh these ideas together and compare these two – what aspects of the biological will we talk about here?

C: Good point. People traditionally use EPT across the board and look at the index to make the comparison but it's not always the best index for comparison across a host of streams and given conditions.

C: One thing we need to be cautious about is the pitfall of circular reasoning. The legislation addresses the question of ecological response to hydrologic alteration. If we end up with a system that addresses the question of ecological response to ecological alteration, we run the risk of being circular in our thought.

C: I'm not sure that's what we are trying to say here. We cannot understand the ecological response as it relates to hydrologic condition unless we know the impacts of the hydrologic condition on that ecology-- meaning, until we can start from a reference condition where we understand what the best absolute place is that ecological can exist. We'll then be in a better place to understand the ramifications of the alternations that we put on that system.

C: I have no problem with that concept, but I would still remind us to be cautious about the potential for circular reasoning, particularly if we end up with an ecological classification for our streams.

R: Keep in mind that NC DWR is looking for some system, classification, characterizing ecology that leads to ecological flows. Characterizing the ecology, and classifying streams whether its hydrologic, biological, or some combination of the two is not an end itself but it is a means to an end. That end is pretty broad-brushed, it will apply to the entire state. Hence whatever we end up both doing in terms of classification as a means to that end, and the approach or approaches we recommend for determining ecological flows, for NC DWR purposes, it has to be something we can do at a multitude of sites with a minimum of site specific data collection.

This was one reason that our first effort at classification had to do with hydrologic classification because it was something that fit neatly into the hydrologic models; it did not require us to go out and collect additional data on all the places that we need to determine ecological flows and before that, know what the classification of the stream is.

I am not saying that we should not have/continue this discussion but we should keep the end in mind in terms of the tasks and the breadth of the tasks.

C: I second that notion. The basic thing we need to be able to do here is come up with a generalizable strategy that allows the state to make good decisions about water allocations at some point in the future. This is why the bill was written. And that generalizable strategy needs to be obtainable using data that we have or can get. If it's not based on that, then however good it is, it won't work.

There are two or three steps we could take. Remember that ELOHA prescribes that we should try to develop ecological baselines for each class. It does not say where the classes come from or anything like that but that we should have some classes and develop ecological baselines for them. And we do have very robust hydrological classes based on a remarkable number of variables.

What we did not have until very recently and what you have not seen is a reanalysis of that data to figure out where every gauge falls within the cluster to which it is assigned. So if you altered the flow at that gauge, you could actually measure the statistical distance it moves within the cluster and get some sense of how much it has actually changed.

If we took all of the NC Heritage data, all the bug data that the NC Division of Water Quality has, and the data the NC Wildlife Resources Commission has in abundance for more common species, and do some sort of fidelity test against the classes to see if there is a high level of organism fidelity to the individual classes, then that sort of validates our classes and gives them a biological dimension. And it's relativity easy to do. We could try it with the existing gauge data, we could try it with the gauges re-simulated using WaterFall to take into account land cover and substrate and those kinds of things. There are several different ways we could do this to model the question of whether organisms have fidelity to the classes that we have.

A second approach that seems to be on the table is to start from scratch and develop a classification system based on some as yet to be determined but basically biological variables or a biological classification system. Is this what's being talked about? The questions seem to be framed in this way, and if so, that is an enormous amount of work. And I'm not sure we have the data to drive it.

R: I do not think the point is to develop a biological classification system, I think that the point is to make sure that within the classification system we are developing that we not only look at the long term gauging stations but that we include any and all available biological data out there as part of that analysis. So the idea is to incorporate the biology into the models better than we have up to this point.

C: Correlating all of the existing biological data with the hydrological data is a good idea but unlike hydrological data, I do not think the biological data is uniform enough or comprehensive enough to develop a parallel classification system. But the way I read these questions, that's on the table.

C: I have a question about the hydrology gauges, that the actual gauging stations were modified to a state where it was unregulated, right?

R: There were 185 gauges that were relatively unaltered; they were not modified but we did toss out the ones that were significantly altered by an upstream reservoir. Now if the gauge had been there a long time prior to when the reservoir had been built, we used only that portion of the record prior to reservoir's construction and actually compared the previous record to the record that took place following the reservoir's construction. If a gauge was not there long enough, we considered it altered.

R: We were basically looking at windows into these gauges and the minimum window size was say 18 years.

C: From a biological or ecological standpoint, when we think of fidelity of species to a particular class of streams, the argument is that it should be either a reference collection of ecological functions or reference collection of species appropriate to that particular class or those particular gauges. Yet, it would be hard for me to see species-by-species fidelity from one side of the escarpment to the Tennessee River. There might be

functional similarities in the species collection but there   is definitely not going to be species by species fidelity to be associated with that class.

C: We may have to split classes in an attempt to achieve something like that. And that would be a good thing to find out. for example, that class D does not support biological fidelity but when it is spilt into two pieces or three pieces, the pieces do. That works as a strategy for me.

C: I want to go back to the part that if we use actual data. I wonder if that data will provide us with that reference type of an approach where we have an unregulated or unaltered ecological or biological system. We need to try to get to that point if we are going to try and tie it to the classification system you all are proposing.

C: I'm not sure what you mean by reference condition, but the pre-European condition of ecological systems is unknown and unknowable. So we are really not struggling to characterize the pre-European conditions or to characterize impacts. Ecological integrity is a significant departure from that. The goal is almost an anti-degradation program. The way the legislation is written now is that the department should be able to identify situations where altering flows will produce significant deterioration of the ecological integrity that exists there now. So we need to be careful of trying to get back to characterizing rivers and streams according to what they may or probably did support a long time ago.

C: I do not think we want to get back to preconditions, but I think we need to be able to put today's condition of an altered stream in context of today's condition of a reference stream. A reference stream is just one in this situation where it is one that is unregulated, the flows are unaltered. I understand the water allocation issues the state is dealing with. It's the reason I brought up Mary Freeman and Jonathan Kennen, because nobody has a bigger water allocation problem than the AFCS Basin in Georgia, Florida and Alabama. This is exactly the kind of data and the kind of problem that USGS, USFWS, Georgia DENR and other agencies have been dealing with for more than 10 years. There are lessons to be learned from the AFCS Basin, I think it would be worthwhile to get the speakers to come specifically for that reason.

C: That would be great. We do have two strategies available to us to come up with models of unaltered conditions or models of unaltered flows. One of those is simply telling Oasis to remove all modifications from the flow of the model. It takes unregulated inflows, passes them through the mouth of the river, and does not at any point along the way introduce human manipulation of flow.

A second approach, which we are looking into and I am recommending that we use at some point, is a WaterFALL simulation of unregulated flows in which we restore the land cover and basically end up with a flow-based model in which we do not have land surface alterations..

C: Chris and Jim are in the queue.

C: Here are some random thoughts. I think in terms of homework or having someone present to us, we can learn something about what other states are doing (reference the *Ecohydrology literature –readings and case studies on what TX, Fl, and VA, are doing).* What general approach are these states taking? It may not be all that ecologically grounded at all, but it would still be good to know how those states got to where they are in their development of flow recommendations. If any of those states or anywhere else that has ecological classifications that they have developed, I think that this even more germane to our discussions. I do not think that there is that much out there though.

Mary Davis mentioned earlier an approach going on in the Northeast, one that the southeast may be interested in trying. It's not strictly an ecological classification but it's a stream classification system we may be able to use and expand within the southeast. Mary Davis may be able to introduce this Northeast approach from the work of Mark Anderson and Arlene Oliviera.

The other thing is looking at the number of topics for the Nov 15 agenda, topic items number 1, 2, and 3. I think the discussion about the classification systems and the reference conditions--I think we would want to have the reference conditions discussion first before tackling the classification discussions.

I would agree about what Judy said earlier about the fidelity and biology thing that if we are going to use species or functional equivalents we need to have that figure that out beforehand before we do any of that work.

Facilitator: It sounds like Mary Davis's task keeps expanding and thus let's make the proposal that we start earlier for our meeting from 12:00pm – 4:00pm (maybe 4:30pm). Mary is online on the webinar and taking notes about the topics you are interested in and what Mark and Tom were interested in hearing about. This would include an overview of ELOHA. What about the topic of fidelity and the reference conditions. Reactions to how to spend the remaining two hours on Nov 15?

C: It would be great to have Freeman and Kennen here on Nov 15. Before we have a conversation about congruence – between hydrology and ecology- we need to discuss how we want to frame that discussion. Lastly, I'm not sure what reference conditions we have in mind so I'm reluctant to dedicate a significant portion of time to that discussion without knowing what we are talking about.

C: I want us to have time to hear from Mary and have time to discuss what she has presented. I am concerned that if we also invite Mary Freeman and Jonathan Kennen we might not have time to gain the full value from all of the presenters, and all are equally important.

C: It would be either Mary Freeman or Jonathan Kennen but not both. And you're right Judy, having two presentations may be too much for one day. I would like to clarify with Mary Freeman what time frame she would need and the focus the EFSAB would like. **We need time to develop the appropriate questions**. I would also like to ask Tom what he meant about reference conditions.

C: I have mixed feelings about hearing about the AFCS in November because of not having enough time to fully absorb what Mary Davis will present. We need time to more fully develop questions for Mary Freeman's presentation.

C: Mary Davis, speaker for the Nov 15 session said she can start at noon. She will cover the collaboration on the ELOHA process.
- What are other states and scientific teams doing
- General stream ecology
- Attempt to expand the Northeast classification in the southeast
- Provide an overview of ELOHA

C: I think the general stream ecology discussion would fit more with Mary Freeman's discussion, not that Mary Davis would not speak to this. And let's not get bogged down into an ELOHA discussion; we can use this information to set the stage. I think our focus should be on what other states are doing which is a multifaceted discussion.

C: I think we will need to process the information that will be presented in order to generate any future questions. We need that time to help us process what additional information we will need presented by other people. I think the case studies will be very useful but how will we process those case studies – By homework? By discussion?

C: One other reservation I have about the presentation on what other states are doing – is can the presentation be framed as a comparative analysis about how other states are addressing ecological flows? Are they doing a good job? Lessons they've learned?

C: Some of the reasons other states may not be achieving their goal is because of the charge they have been given.

C: One point I'd like us to consider is that I am very comfortable with what Jim has been doing. What I am interested in is how this discussion can inform what Jim has been doing.

R: Actually, some of the things that came up today will lend themselves to the Nov discussion such as the Tar River coming out as a small flashy stream (when we do not think it is the same as the Eno). Does this then suggest that we need to have some other layer of classification there or maybe we split things too finely, maybe they are close enough. That's why looking at what other states are doing could be very helpful.

C: One last thing, about the Nov agenda, I hope this is not the first and last biological or ecological discussion but the first of many as we wrestle with this topic and the ideas raised. It is an important topic for several people.

C: Yes, but I would hope that our discussions are focused and will get more on the ecological response than just the ecology and classes A through whatever - as this is just a means to an end.

Facilitator: As a recap, for Nov 15 we will have Mary Davis present on the following topics:
1. Focus on what other states and teams are doing, and this will include discussion time.
2. Overview of ELOHA
3. Report on what the Northeast is doing and if this effort is applicable to the southeast.

Thomas Cuffney will present on the following:
4. Examine the current "state-of-the-art" in terms of species attributes (e.g., a database of lotic invertebrate traits for North America; is there a way to couple this with fish and mussel traits?)

5. At the end of the November meeting, the group will develop a set of questions on which Mary Freeman can focus her presentation for the January meeting. Holly Weyers will follow up with Mary. Mary Freeman is expected to present about the following topics:
   a. Discussion of General Stream Ecology and Flow Relationships in the Southeast using the AFCS Basin as context.
   b. Transferability of species preferences--can you take the preferences of fish in one river and apply it to another river with similar characteristics?
   c. How can we do things here in NC as a result of what we heard?

VII.   EFSAB Charge: Framing a Discussion

A review of the charge was briefly initiated to help frame a discussion about the charge. Several members of the EFSAB have questions about the charge. Mary Lou Addor revisited the roles and responsibilities of the EFSAB presented at the initial convening meeting (Nov 2010). The topics covered were:
   A. The EFSAB: What it is;
   B. The EFSAB: What it is not;
   C. The Purpose and Authority of the EFSAB.

This discussion was followed with three questions. The EFSAB had time to respond to the first questions.

A: The EFSAB: What it is
1. Members with a strong background in aquatic ecology
2. An expert panel to collectively:
    a. Review all relevant studies
    b. Reports
    c. Other pertinent information
3. Based on the review and discussions:
    a. The EFSAB will advise DENR on an approach to characterize the ecology of river basins and a method to determine the flows necessary for ecological integrity.
4. A board to develop an approach for planning purposes that will help users meet anticipated water needs in the future and address concerns at a watershed level that includes cumulative effects.
5. A board to provide scientific input as part of a broader stakeholder process

B: EFSAB: What it is not:
1.   Not the final decision-maker
2.   SAB will advise on approaches and methods, not specific flow numbers
3.   Not trying to develop a method to replace site specific studies needed for a specific EA/EIS permit review

C: Purpose and Authority of the SAB

Purpose: the EFSAB will advise DENR on approaches to characterize the aquatic ecology of different river basins and identify the flows necessary to maintain ecological integrity. The group will focus on methods of determining flows necessary to maintain ecological integrity.

Authority: The EFSAB is charged with assisting DENR in characterizing the natural ecology and identifying flow requirements, and reviewing reports or studies submitted to the DENR for consideration that are relevant to characterizing the ecology of the different river basins.

Questions for the EFSAB:
1. Interests: what's important to you to help advise DENR on approaches to characterize the aquatic ecology of different river basins and identify the flows necessary to maintain ecological integrity?
2. What issues need to be addressed?
3. What options might help you address those issues?

Discussion

1. **3 Different Scales:** A concern I have has to do with characterizing the aquatic ecology of different river basins, found in the authority of the EFSAB. Our current classification is hydrology based, and hydrology is one of many factors that define each of these river systems. So it's the different scales that create the difficulty in operating between them.

    a. Statewide scale: we are being asked for a state-wide application to get at flow recommendations.
    b. River Basin Scale: then we are being asked to characterize the aquatic ecology of different river basins.
    c. Flow Characteristics Scale: the current classification system we are working with does not describe ecology, it describes flow characteristics. We need to move beyond this to ecological aspects.

2. **Climate change** is the elephant in the room especially with respect to planning purposes. Sometime, somewhere I think we will need to discuss climate change as it pertains to planning.

> C: It is true we have not talked about climate change and it was not mentioned in the legislation. One thing we can do is use various climate change models to predict future precipitation then predicting future precipitation to model/predict future flows and to develop predictive strategies for ecological integrity. I am concerned that the results will not make me happy. We are building tools that have the capacity to model the effects of climate change on future hydrological regimes.

3. **Scale i**s the crux of the ecology issue in our charge. We can be very broad brushed; **we can discuss ecology of trout streams and warm water streams (that is a classification system that is biological based). But is that good enough? Or we can get down to the gnat's teeth on this.** I believe what we are struggling with what is **science based ecology?** Some of what Mary Davis can help us with is the contextual information from other states and where do we fit in with that scale for how other states have tackled this issue. Some of them, whether they are calling it ecological or not, it's clearly not; and others are clearly trying to do good science and be informed by it.

To me this is the issue, we are going to continue to struggle and muddle through this as difficult as it seems from month to month until we center around where we feel like we got it captured without going into the weeds.

4. **We cannot ignore the ecological** that is listed in the charge. The presentations will not solve it overnight but through a series of presentations and examinations, this group will come up with a set of criteria we are comfortable with.

5. **The underlying assumption behind the classification system is that the difference in hydrology leads to difference in ecology** and sometime it's easier to measure differences in hydrology than differences in the ecology. It will not be perfect; there will be outliers but the question is, is it a good enough fit. If it's not, then what should we do differently.

6. **End Result and How will be it measured?** Following up with what Sam brought up earlier, about coming up with an end result or an end approach, meaning how to allow for water allocation without degrading the ecology of our waters and streams, I feel like we may need to take some time to look at what our vision will be, what the end result will be so that we can walk backwards on process to get at that end result.
> For example, if we are looking at an anti-degradation approach, we would need a method to measure departure from either the current state or a reference state. We are going to be measuring something at the end to determine whether or not these flows are actually supporting what we think they would support and what ecological function.

What in the field would we be measuring at the outcome to make sure the flow scenario we recommended after the EFSAB process is over, is not actually degrading the ecological functions? The classification we chose for the ecology should be comprised of whatever it is we are going to measure. When DWQ goes out they measure EPTs, IBIs for fish, they measure ambient chemicals because there is a departure that they can measure to say whether water quality is degraded or not degraded. As scientists I think we need to come up with what are we going to measure as a departure in order to

determine that the ecological flows we are prescribing are actually meeting the expectations. And walk back from there. It might be we do need to measure EPTs but it may be that we can just get by with measuring the hydrology.

> C: I do not disagree with your comments, but I am concerned that we approach this question of classification carefully. I want to be sure that we do not declare a reference condition that is not obtainable or develop a classification strategy that is not supported by the data. I use the phrase almost an "anti-degradation strategy" because in fact the legislation originally said natural conditions. Some folks notably took much issue with the word "natural"; the word "natural" came out and the word "prevailing" went in, and prevailing conditions became the baseline for NC's rivers. Prevailing conditions are further defined as the period of record for rivers. So we are not stuck with the way they are today; we have the ability to look at what conditions prevailed for the period of record.

> C: Question: is that prevailing condition the abundance of any particular species? Is that diversity of species at a particular location? I think we will need to decide what the condition is that we are going to measure. Otherwise we cannot decide what our ecological classification is going to be based on.

> C: Agree - where I came out on this is that we can measure hydrology everywhere and we can simulate alterations in hydrology relatively easily. The literature tells us that the hydrology is by far the most important variable in aquatic habitat. I was hoping we could basically stratify our sample, that is classify the state using hydrology, and then look at ecological responses to it. The ecological data are far less consistent and less available. As a result, it is really hard to hang your hat on ecological data writ inclusively.

> However, if USGS and others can bring data to the table to allow us (Heritage data has great potential for this), if we can bring additional biological data to modify the hydrologic classification system to perhaps subset classes or better describe classes so that in the end we have a more robust system to look at ecological responses to hydrological alterations, then rock n roll. I am just worried that we will commit to something we don't have and we can't get. So let's be careful that we do not commit to a classification system to drive a state planning and management program, a classification system that we cannot get to from here.

7. **Expectations of the Session Law:** let's step back a little further to the legislation session law that directs DENR to develop basin wide hydrologic models for each of the 17 river basins in NC. It told us the kind of things that had to be included in those models. Ecological flows is one of those things and the purpose of this EFSAB. DENR is looking to incorporate the recommendations that come from the EFSAB into the basin-wide models. We have 100s of nodes out there with any kind of water withdrawal or alteration; we want to be able to incorporate the data on ecological flows, and we do not know how we are going to do that. The EFSAB needs to think with that end in mind,

what DENR will be required to do and how we best incorporate that into river basin wide models on streams with gauges and streams without gauges.

    a. C: And the legislative language described ecological flows and ecological integrity. Reference the legislative language that describes (section 2, (3) that each basin wide hydrologic model shall ....predict the places, times, frequencies and intervals in which the following may occur.....ecological flows may be adversely affected. Ecological flows are defined as flows necessary to maintain ecological integrity and then ecological integrity is furthered defined in the legislation.

8. **Define ecological integrity,** define the criteria that are ecologically based because at the end point, we won't know if we've altered the ecology or not; the hydrologic model won't tell us that. And so we need a good set of ecological attributes that we know we want to go after, and those are the ones we are going to measure at the end in order to determine if we affected or had an impact as we alter the flow.

VIII. Directions to November 15, 2011 Meeting

The next meeting will be in the Auditorium Room at the **Wake County Agriculture Services Building**. 4001 –E-Carya Drive, Raleigh, NC 27610, beginning at 12:00pm **and is expected to end between 4:00 and 4:30pm. We are completing agenda items for the Nov 15 meeting.**